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SOIL CONSERVATION SERVICE

FALLOW AND THE WIND EROSION HAZARD

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Fallowing of land for soil-moisture storage to stabilize wheat production has been studied at various locations in the wheat-producing area of the Great Plains for a number of years. Although substantial increases in crop yields have resulted from fallow, as compared with continuous cropping, there is a certain amount of risk involved from the standpoint of wind erosion.

CLIMATIC CONDITIONS

Average precipitation over the western part of the Great Plains area borders on the minimum required for crop production. This makes variations from year to year very important. Variability in the annual amount of precipitation is greater in the Southern Plains States than in the States farther north. Annual precipitation at the Amarillo Experiment Station during the past 12 years has ranged from 12.13 inches to 32.56 inches with a 12-year annual average of 18.88 inches.

The growing season at the Amarillo station has an average length of 197 days and extends from April 14 to October 29. The average length of growing season in the extreme northern part of the Great Plains is from 100 to 120 days and gradually increases to about 160 days in west-central Kansas. Farther south, the period of time for weed growth and high evaporation rates increases.

Winds of high velocity (20 to 35 miles per hour at the 2½-foot level) can be expected during the winter and spring months in the Southern High Plains area. The strongest winds occur during the first 4 months of the year and reach a peak in March or April. This is the period when land in a fallow condition must have residues from previous crops on the surface to prevent wind erosion.

The erratic climatic conditions in this area emphasize the importance of using every possible means to store and utilize soil moisture for crop production and to provide, at the same time, protection to the land from wind erosion.

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[1] Studies are cooperative between the Soil Conservation Service--Research and the Texas Agricultural Experiment Station.

SOILS

Since the main purpose in fallowing is to conserve moisture, the ease with which water enters the soil has much to do with the effectiveness of the practice. The receptiveness of soil to moisture is partly inherent and partly due to the way the soil is managed. Thus, the fine-textured, heavy soils commonly used for wheat raising, are by nature dense and slowly penetrated by water. In addition, some soils cleave or crack in vertical planes which affords ready entry to water, while others crack horizontally and are less receptive to moisture. This naturally slow permeability can be aggravated by poor management practices. Cultivating the soil when it is too wet results in the formation of compact layers at the depth of plowing which restrict water movement. Leaving the surface bare during the summer months makes it vulnerable to the splattering or compacting effect of driving summer rains which cause it to become sealed. The amount of moisture that can be stored during a season of fallow will average somewhere between 20 and 35 percent of the annual precipitation, depending on soil and climatic conditions and the way the land is managed. Moisture storage in the soil may be increased by the following measures:

1. Providing a protective layer of surface residues as by stubble-mulch farming which slows up runoff and increases moisture intake.

2. Avoiding cultivation when the soil is in a plastic or easily compacted condition that would lead to the formation of a tillage pan or plow sole.

3. Adequately controlling weeds but not wasting moisture or causing excessive pulverization of the surface soil by unnecessary cultivation.

One undesirable effect of cultivation is the loss of the dark-colored organic matter of the surface soil. This material helps to keep the soil in good tilth. When it is lost the soil becomes intractable and has undesirable physical properties. It also serves as a storehouse for nitrogen and phosphorus. The more frequently a soil is cultivated and the greater the length of time it lies bare and exposed to the weathering or oxidizing effect of the sun and the elements, and to action of wind in the wind erosion process, the greater is the loss of its organic matter. Of the various wheat-cropping systems, the ''continuous-wheat'' system is probably the easiest on the soil and is less destructive of organic matter than the wheat-fallow-wheat method.

STUDIES CONDUCTED

Studies of different methods of managing fallow land for wheat production have been under way at the Amarillo Conservation Experiment Station for the past 9 years (1943-51). In these studies, a wheat-fallow-wheat rotation has been followed, using the following methods of tillage:

1. Clean fallow using the one-way disc plow for all plowing and tillage operations.

2. Stubble-mulch subsurface tillage for all operations starting

immediately after harvest and continuing through the entire fallow period often enough to keep down the growth of weeds and volunteer wheat.

3. Delayed stubble-mulch subsurface tillage where the stubble is left undisturbed without any plowing operations until weed growth starts the following spring. This fallow system is designated ''delayed fallow.''

This report deals primarily with the use of delayed fallow for minimizing the danger of wind erosion and its value for maintaining dependable crop production.

CROP YIELDS

Wheat following fallow has given substantially larger yields than wheat after wheat, especially during the drier years (table 1). During the period 1943-51, precipitation for the crop year (July 1 to June 30) at the Amarillo station ranged from 13.5 inches to 27.0 inches, with a 9-year average of 18.9 inches. A comparison of yields shows a 9-year average of 12.8 bushels per acre from continuous cropping of wheat and 20.1 bushels per acre from a wheat-fallow-wheat rotation. With continuous cropping there were 5 years out of 9 with crop yields from 6.0 bushels per acre to 8.6 bushels per acre. Yields from the wheat-fallow rotation in the same 5 years ranged from 10.8 bushels per acre to 23.3 bushels per acre. There was a complete crop failure under all systems of culture in 1950 due to drought and greenbugs. Since it takes approximately the first 5 bushels to cover all crop expenses, little profit was made during these 5 years from continuous cropping. There were 3 years with high yields from both cropping systems. Continuous wheat ranged from 19.4 bushels per acre to 34.3 bushels per acre and wheat-fallow-wheat from 28.4 bushels per acre to 38.4 bushels per acre. During the dry years, yields on fallow were from two to three times those from continuous cropping. From these results, it can readily be seen that fallow in the cropping system stabilizes crop production and thus helps to produce a more dependable year-in and year-out farm income.

TABLE 1.--Wheat yields on continuous wheat vs. wheat-fallow-wheat
Amarillo Experiment Station, 1943-51

Year	Precipitation 7/1 to 6/30	Continuous wheat (subtillage)	Wheat-fallow-wheat rotation	
			Early subtillage	Delayed subtillage
	Inches	Bu. per acre	Bu. per acre	Bu. per acre
1943	17.3	7.1	14.6	12.9
1944	21.2	26.4	28.4	30.3
1945	15.7	6.9	20.4	23.3
1946	13.5	6.0	13.9	15.4
1947	20.8	34.3	36.8	36.2
1948	13.6	6.2	15.7	15.6
1949	27.0	19.4	38.4	36.1
1950	16.1	0	0	0
1951	25.3	8.6	13.0	10.8
Average	18.9	12.8	20.1	20.1

The average 9-year yields from the wheat-early fallow and wheat-delayed fallow methods were the same; i. e., 20.1 bushels per acre. With delayed fallow, all crop residues can be left on the surface for protection during the winter and spring blow season.

RESIDUE CARRY-OVER

Measurements of the amount of residue carry-over during the fallow period were made in 1943 and 1950. The period covered was from wheat harvest to the following harvest for both years. This does not cover the entire fallow period but covers the most important part from the standpoint of wind erosion.

In 1943, the measurements were made on plots where rates of wheat-straw residue and types of tillage were being tested. The amounts of residue remaining on the plots after a year in fallow are shown in table 2.

TABLE 2.--Residue carry-over from harvest 1942 to June 1943

Tillage treatment	Straw per acre July 1942	Straw per acre June 1943	Percent of original amount
	Pounds	Pounds	
Stubble-mulch tillage	3,000	2,081	69
Stubble-mulch tillage	1,500	738	49
One-way disc plow	3,000	916	31
One-way disc plow	1,500	470	31

The proportion of residue carried over was the highest on the plots with stubble-mulch tillage. There were 2,081 pounds per acre still on the surface at the end of a year on the plots which originally had 3,000 pounds per acre, and 738 pounds per acre remaining on the 1,500-pound plots. On a percentage basis, 69 percent of the residue under the 3,000-pound rate and 49 percent of the residue under the 1,500-pound rate was still on the surface. Considerably less residue was left on the surface on the plots that were plowed with the one-way disc plow. Only 31 percent of the original amount of straw remained on both the 3,000-pound and 1,500-pound rates.

The same type of information was secured from the stubble-mulch plots in 1950 on one-wayed fallow, early subtilled fallow, and delayed subtilled fallow (table 3).

TABLE 3.--Residue carry-over from harvest 1949 to June 20, 1950

Tillage treatment	Straw per acre July 1949	Straw per acre June 1950	Percent of original amount
	Pounds	Pounds	
One-wayed fallow	5,142	617	12
Early subtilled fallow	6,140	3,500	57
Delayed subtilled fallow	5,875	3,290	56

Wheat-straw residue from the 1949 crop was exceptionally heavy. Measurements immediately after harvest showed 5,142 pounds per acre on one-wayed fallow, 6,140 pounds per acre on early subtilled fallow, and 5,875 pounds per acre on delayed subtilled fallow. At the end of a year's time in fallow, 12 percent of the residue still remained on the surface of the one-wayed fallow, 57 percent on early subtilled fallow, and 56 percent on the delayed subtilled fallow.

This information indicates that with stubble-mulch tillage you can expect to have about 60 percent of the residue still on the surface after a year of fallow. However, the proportion is much less, from 12 to 31 percent of the original amount, when the one-way plow is used during the fallow period (figs. 1, 2, and 3, page 6).

Crop-residue measurements taken on the stubble-mulch plots at harvest time for a number of years show the large differences in the amounts of wheat-straw residue produced from year to year under the continuous-wheat and wheat-on-fallow systems (tables 4 and 5).

TABLE 4.--Wheat-straw yields, continuous wheat, in pounds per acre

Tillage practice	1943	1944	1945	1946	1947	1949
One-way disc plow	1,451	2,705	601	700	3,664	3,793
Subtillage plow	1,512	2,091	439	1,040	3,560	3,236

TABLE 5.--Wheat-straw yields, wheat-fallow-wheat rotation, in pounds per acre

Tillage practice	1943	1944	1945	1946	1947	1949
One-way disc plow	2,270	3,135	922	1,474	----	5,962
Subtillage plow	2,462	3,152	1,038	1,676	----	6,359

On continuous wheat, the amount of straw produced varied from 439 to 3,793 pounds per acre. The production on fallow was much higher with variations from 922 to 6,359 pounds per acre. A high or low straw yield does not necessarily mean a correspondingly high or low grain yield. This is illustrated by the yield of 14.6 bushels per acre on subtilled fallow in 1943 with straw yields of 2,462 pounds per acre as compared to the 1945 subtilled-fallow yield of 20.4 bushels per acre with 1,038 pounds of straw per acre.

The effectiveness of a surface mulch or residue in controlling wind erosion is a matter of common knowledge. All other factors being equal, the system of handling land which will keep the most residue on the surface will be the most desirable from the standpoint of erosion control. Information obtained in this study (tables 2 and 3) emphasizes the much greater amount of crop residue left on the surface with subtillage as compared to one-waying. Maintaining the maximum amount of surface residue means the use of stubble-mulch tillage for all plowing and tillage operations regardless of the amount of residue produced. If properly managed, heavy residues will carry over into the second

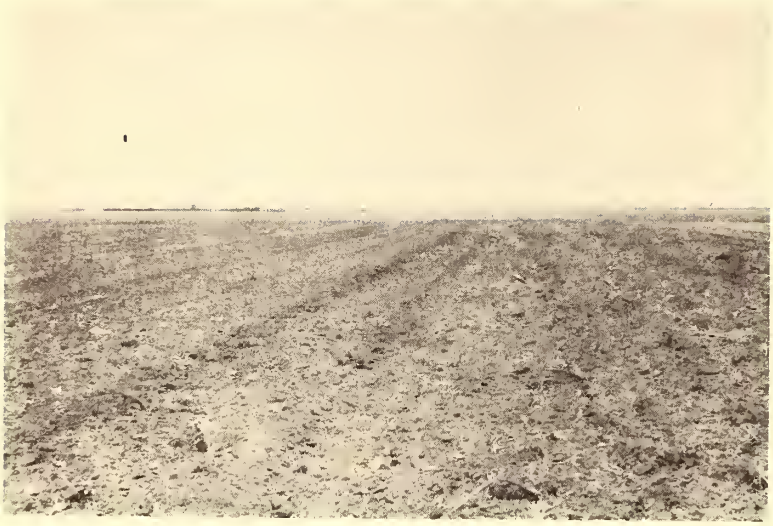
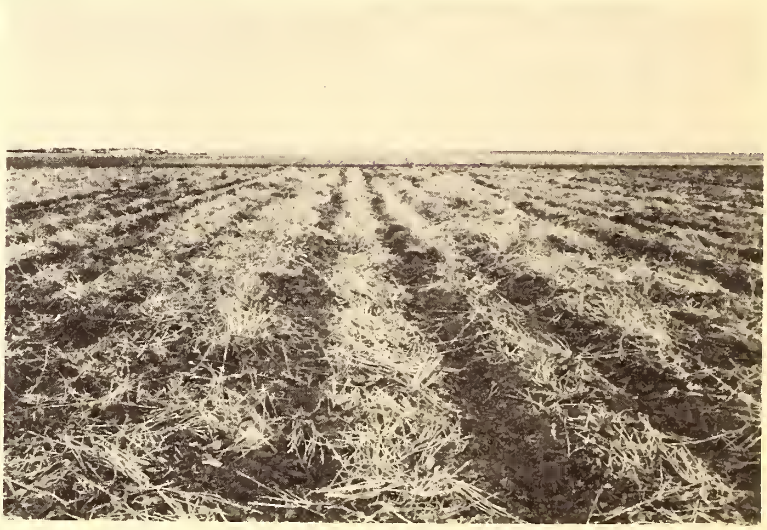


FIGURE 1.--Appearance of one-wayed fallow plot on June 17, 1950, after fourth cultivation. Cultivation was started immediately following wheat harvest in 1949. Surface residue amounts to 617 pounds per acre, or 12 percent of original amount.

FIGURE 2.--Appearance of subtilled fallow plot on June 17, 1950, after four cultivations. Cultivation was started immediately following wheat harvest in 1949. Surface residue amounts to 3,500 pounds per acre, or 57 percent of original amount.



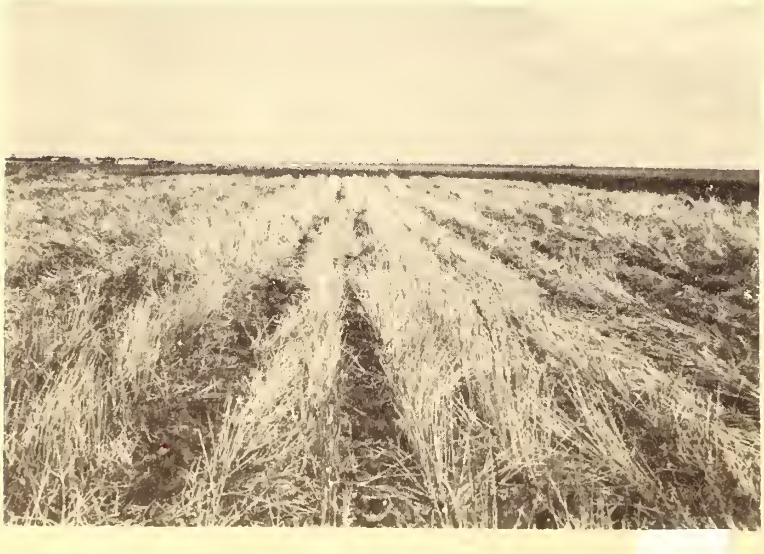


FIGURE 3.--Appearance of delayed subtilled fallow plot on June 25, 1950, after first cultivation. Surface residue amounts to 3,300 pounds per acre, or 56 percent of original amount. There were no cultivations on this plot from wheat harvest 1949 until the spring of 1950. Note that more of the residue is standing up on this plot than on plot which had been cultivated four times.

year, an important consideration when wheat fails to produce a protective cover or there is a crop failure. Heavy utilization of wheat stubble by livestock will tend to greatly decrease the amount of protective residue left on the soil.

OTHER STUDIES IN THE GREAT PLAINS

Studies on methods of fallow have been conducted at various locations over the Great Plains for a number of years. A summary of this information taken from State and United States Department of Agriculture bulletins covering results of this work is given in tables 6 and 7.

The comparative yields of continuous wheat and wheat-fallow-wheat are given in table 6. This information was from the following locations: Ardmore, S. Dak.; Akron, Colo.; Hays, Kans.; Colby, Kans.; and Garden City, Kans. The average annual precipitation for the six locations is 18.07 inches with variations from 16.36 inches at Ardmore to 21.61 inches at Hays. Average crop yields following fallow are about double the yields on continuous cropping at all locations except Hays and Amarillo. The largest increase in yield on fallow seems to be at the locations with the smaller amounts of precipitation, especially in the northern Plains where evaporation rates are much lower than in the southern Plains. The average yields for all locations are 10.0 bushels per acre for continuous wheat and 17.4 bushels per acre under a wheat-fallow-wheat rotation.

TABLE 6.--Comparison of wheat yields under wheat-fallow-wheat and continuous-wheat systems*

Location of experiment	Years tested	Average annual precipitation	Yield per acre	
			Continuous wheat	Wheat-fallow-wheat
		Inches	Bushels	Bushels
Ardmore, S. Dak.	1913 - 1930	16.36	9.5	19.9
Akron, Colo.	1909 - 1938	17.09	7.1	16.3
Hays, Kans.	1908 - 1939	21.61	16.7	23.5
Colby, Kans.	1915 - 1939	17.32	8.4	15.7
Garden City, Kans.	1910 - 1939	17.16	5.7	9.0
Amarillo, Tex.	1943 - 1951	18.88	12.8	20.1
Average		18.07	10.0	17.4

*Data for all stations except Amarillo taken from the following published bulletins:

Throckmorton, R. I., and Myers, H. E. Summer Fallow in Kansas. Kans. Agr. Expt. Sta. Bul. 293. 1941.

Brandon, J. F., and Mathews, O. R. Dry Land Rotation and Tillage Experiments at the Akron (Colorado) Field Station. U. S. Dept. Agr. Circ. 700. 1944.

Mathews, O. R., and Clark, V. I. Summer Fallow at Ardmore, S. Dak. U. S. Dept. Agr. Circ. 213. 1932.

TABLE 7.--Comparison of wheat yields under wheat-delayed fallow-wheat and wheat-early fallow-wheat systems*

Location of study	Years tested	Average annual precipitation	Yield per acre	
			Wheat-early fallow-wheat	Wheat-delayed fallow-wheat
		Inches	Bushels	Bushels
Havre, Mont.	1917 - 1923	11.16	9.0	9.1
Akron, Colo.	1923 - 1938	16.13	12.5	12.3
Hays, Kans.	1914 - 1939	21.61	24.5	25.3
Colby, Kans.	1922 - 1939	17.32	14.2	15.4
Garden City, Kans.	1914 - 1939	17.16	13.2	10.9
Amarillo, Tex.	1943 - 1951	18.88	20.1	20.1
Average		17.06	15.6	15.5

*Data for all stations except Amarillo taken from the following published bulletins:

Throckmorton, R. I., and Myers, H. E. Summer Fallow in Kansas. Kans. Agr. Expt. Sta. Bul. 293. 1941.

Brandon, J. F., and Mathews, O. R. Dry Land Rotation and Tillage Experiments at the Akron (Colorado) Field Station. U. S. Dept. Agr. Circ. 700. 1944.

Morgan, G. W. Experiments with Fallow in North-Central Montana. U. S. Dept. Agr. Bul. 1310. 1925.

In other studies of the fallow method made in various parts of the Great Plains, fallow with early fall tillage has been compared with fallow and first plowing in May. Under the latter method, all plowing from harvest until the following spring is eliminated as in the ''delayed fallow'' method studied at the Amarillo station. The studies were made at Havre, Mont.; Akron, Colo.; Hays, Kans.; Colby, Kans.; and Garden City, Kans. Results, as reported in various State and United States Department of Agriculture bulletins, show that in these areas, as at the Amarillo station, there is little difference between the yields obtained by the two methods (table 7). The average yields of the two fallow systems for all locations are about the same; i. e., 15.5 and 15.6 bushels per acre. The only place that showed a decrease in yield from delayed fallow was Garden City, where the yield was 13.2 bushels on wheat-early fallow and 10.9 bushels on wheat-delayed fallow.

SUMMARY

Results of comparative studies of wheat production under the wheat-fallow and continuous-wheat systems at different localities in the Great Plains show that the fallow method gives sufficiently greater yields and sufficiently more dependable average yearly production to justify its more extended use. Fallow, as ordinarily practiced in the past, has not been used extensively in many areas because of the danger of wind erosion when the land is left idle.

The delayed-fallow system, under which the land is left undisturbed without any plowing or cultivation from wheat harvest until the following spring, is much the safer method to use on land susceptible to wind erosion. Residues left standing are more effective for controlling wind erosion during the winter and spring blowing season than residues that have been plowed. This is especially true when low crop yields or crop failures result in the production of only small amounts of crop residues. Even with stubble-mulch plowing following harvest, some of the effectiveness of the wheat stubble for controlling wind erosion is destroyed. The large variation from year to year in wheat-straw yields as compared to grain yields also emphasizes the importance of keeping the greatest possible amount of residue on the land surface every year. A maximum of crop residue can be maintained during the entire fallow period by using stubble-mulch tillage for spring and summer cultivations. This surface residue left after a year in fallow will often be sufficient to stabilize the soil after the land has been seeded to wheat.

The delayed-fallow system is not only safer to use than the system under which fallow land is plowed directly after harvest, but according to results obtained over the Great Plains area, it is also more profitable, since it gives equivalent yields with a third fewer cultivations.

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